Original Article

The use of artificial intelligence in anesthesiology: Attitudes and ethical concerns of anesthesiologists

ABSTRACT

Background: Existing studies on anesthesiologists' attitudes toward artificial intelligence (AI) leave a global understanding underexplored. This cross-sectional study aims to investigate Turkish anesthesiologists' attitudes toward AI, examining its perceived benefits, limitations, and associated ethical concerns. Insights from this study aim to enhance understanding of AI's role in anesthesiology within a cultural and ethical context.

Methods: This nationwide study surveyed Turkish anesthesiologists. Descriptive statistics summarized categorical variables, Pearson's Chi-square test compared variables between groups. Binary logistic regression analyzed associations between demographic factors and positive attitudes toward AI.

Results: Among 293 valid responses, 69.6% of participants expressed positive attitudes toward AI. Gender ($P = 0.01$), employment setting ($P < 0.001$), and prior AI experience ($P < 0.001$) were significant predictors of positive attitudes. AI applications most frequently endorsed included preoperative assessments (93.1%), academic support (95.2%), and medical education (91.2%). Ethical concerns were prominent, with liability ambiguity (87.3%) and privacy issues (62.8%) being the most cited. Logistic regression revealed that participants aged 46–55 were significantly more likely to exhibit positive attitudes (OR = 3.744, $P = 0.03$), while those with over 15 years of experience were less likely to do so (OR = 0.105, $P = 0.04$).

Conclusions: Turkish anesthesiologists exhibited predominantly positive attitudes toward AI, with prior experience playing a significant role in shaping perceptions. While AI was embraced for academic, educational, and noninvasive tasks, skepticism was present toward its application in invasive procedures. These findings highlight AI's potential to enhance efficiency and patient safety while underscoring the need for comprehensive legal and ethical frameworks.

Key words: Anesthesiologist, artificial intelligence, attitude, ethics, perception

Introduction

Artificial intelligence (AI) is a field of computer science focused on creating systems capable of simulating human intelligence to perform tasks autonomously. It involves the study of algorithms that enable reasoning, decision-making, problem-solving, and data analysis.[1] AI in medicine reached a significant turning point between 2015 and 2018, marked by a consistent annual increase in research and publications, driven primarily by rapid improvements in computational power and the growing availability of large-scale healthcare datasets, records, and databases.[2,3]

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Selin Erel, Aslihan G. Kiliç

Department of Anesthesiology and Reanimation, Gazi University Faculty of Medicine, Ankara, Turkiye

Address for correspondence: Dr. Selin Erel, Department of Anesthesiology and Reanimation, Gazi University Faculty of Medicine, Ankara, Turkiye. E-mail: selinerel@yahoo.com

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The application of AI in anesthesiology has grown remarkably, paralleling advancements in technology across healthcare.[3,4] This expanding role includes risk assessment, complication prediction, pharmacological modeling for anesthesia, and robotic-assisted procedures.[5,6] These innovations promise greater precision and efficiency. While the positive aspects of AI, such as improved time management and enhanced outcomes, are widely acknowledged, ethical dilemmas loom large.[7] Key concerns include the reliability of AI due to the opacity of "black box" models, that is, an AI-powered algorithm where the input data and output results are visible, but the process connecting them remains unclear and lacks interpretability, potential biases in algorithms, issues surrounding privacy and confidentiality, and questions of paternalism and accountability in clinical practice.[8]

Although surveys examining the attitudes of anesthesiologists toward AI have been conducted in various countries, including Saudi Arabia and the United States, these studies reflect society-specific perspectives, and the attitudes of anesthesiologists from diverse backgrounds and cultures have not been sufficiently explored on a global scale. Therefore, we aimed to focus our study specifically on anesthesiologists in Turkey to address this gap.

This cross-sectional study aimed to explore Turkish anesthesiologists' attitudes toward the use of AI in their daily and professional practices. It sought to identify factors influencing these attitudes, highlight the perceived benefits and limitations of AI, and address the ethical concerns prevalent among practitioners. By shedding light on these perspectives, the study contributes to a deeper understanding of the intersection between AI innovation and ethical responsibility in the evolving field of anesthesiology.

Materials and Methods

This nationwide online survey of Turkish physician anesthesiologists follows a cross-sectional design.

Sample design and data collection protocol

The study population included anesthesiologists who voluntarily consented to participate in the survey. Members of the Turkish Society of Anesthesiology and Reanimation were invited to participate via email, where a survey link was shared. Inclusion criteria were limited to licensed anesthesiologists and traniees who agreed to provide complete survey responses. Respondents who failed to complete the survey in its entirety were excluded from the study. Data collection was conducted from November 7, 2024 to December 31, 2024 without the issuance of any reminder emails.

Survey ınstruments

A structured questionnaire was developed using the SurveyMonkey platform to assess participants' perceptions and attitudes. The development of survey questions was based on previous cross-sectional studies in the field of anesthesiology,[9,10] and new question roots to identify demographic characteristics, perspectives on AI, and future of AI in anesthesiology deeper were added. After the final revision, survey included 18 questions and five main divisions: participant demographics, general AI use, AI use in anesthesiology, perceived advantages and disadvantages of AI in clinical settings, and ethical concerns. The survey responses were collected anonymously.

Outcome measurement

The primary objective of this nationwide cross-sectional study was to evaluate participants' familiarity with AI technologies, attitudes toward AI implementation in anesthesiology, and concerns regarding associated ethical challenges. Attitudes toward AI were assessed using a 5-point Likert scale, where responses ranged from 1 ("strong disagreement") to 5 ("strong agreement"), with higher scores indicating more favorable perceptions of AI adoption. These attitudes were categorized as positive, neutral, or negative based on the recorded responses.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 26.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to summarize categorical variables as frequencies and percentages. Pearson's Chi-square test was applied to compare categorical variables between independent groups.

A binary logistic regression analysis was conducted to examine the associations between demographic variables and the likelihood of exhibiting a positive attitude toward the integration of AI in clinical practice. Neutral and negative responses were consolidated into a single category to facilitate the regression analysis. The multivariate model included variables such as age, gender, years of experience, employment place, academic title, workplace role, and prior exposure to AI. The model's adequacy was evaluated using the Hosmer-Lemeshow test. Odds ratios (ORs) with 95% confidence intervals were calculated and reported. A P value <0.05 was considered statistically significant for all analyses.

Results

A total of 4652 members of the Turkish Society of Anesthesiology and Reanimation were invited to participate in

the survey. The initial dataset comprised 322 responses. After excluding submissions with duplicate IP addresses ($n = 5$) and incomplete data ($n = 24$), 293 valid responses were included in the final analysis, yielding a total response rate of 6.81%.

The majority of participants were between 25 and 35 years old (51.2%) and predominantly female (58.0%). Most respondents were trainees, having 0 to 5 years of experience in the field (45.4%), and were primarily employed at university hospitals (49.8%). A significant proportion (85.0%) reported working in operating rooms or intensive care units, while a smaller group balanced clinical and academic responsibilities, Table 1.

Participants' attitudes toward AI varied, with 69.6% expressing a positive perspective, 27.3% remaining neutral, and 3.1% expressing a negative attitude. The analysis revealed no significant relationship between age and attitudes toward AI ($P = 0.37$). However, gender was significantly associated with attitudes ($P = 0.01$). Among female participants, 67.1% had a positive attitude, 31.8% were neutral, and 1.2% held a negative view, whereas male participants exhibited slightly higher positivity, 73.2%, 21.1% remained neutral, and 5.7% reported a negative view.

No significant relationship was found between years of experience as an anesthesiologist and attitudes toward AI ($P = 0.1$). However, the employment place was significantly associated with their perspectives on AI ($P < 0.001$). Positive attitude toward AI among training-research hospitals, university hospitals, private hospitals, and state hospitals was 80.6%, 71.2%, 62.5%, and 57.1%, respectively. Retired or unemployed participants showed the lowest positivity rate, with 25.0% expressing a positive attitude, 50.0% remaining neutral, and 25.0% holding negative views.

While workplace roles, such as working in operating rooms or intensive care units, were not significantly associated with AI attitudes ($P = 0.08$), academic titles showed a meaningful relationship ($P = 0.02$). Trainees demonstrated a high level of positivity, with 71.3% expressing a positive attitude, 27.8% remaining neutral, and only 0.9% holding a negative view. Among specialist doctors, 66.1% reported a positive attitude, 28.6% were neutral, and 5.4% were negative.

Table 1: Demographic characteristics of the participants and multivariable logistic regression of factors associated with positive attitude toward the use of AI in clinical practice

Demographic Characteristics		Multivariate Logistic Regression	
Variable	***n* (%)**	**Odds ratio (95% CI)**	***P***
Age			
25–35	150 (51.2)	Nil	0.03*
36–45	64 (21.8)	0,87 (0,24–3,157)	
46–55	43 (14.7)	3,744 (0,661–21,219)	
>55	36 (12.3)	0,372 (0,036–3,803)	
Gender			
Female	170 (58.0)	Nil	0.37
Male	123 (42.0)	1,377 (0,679–2,792)	
Years of Work Experience			
0–5 year	133 (45.4)	Nil	0.04*
6–15 year	80 (27.3)	0,313 (0,08–1,22)	
>15 year	80 (27.3)	0,105 (0,018–0,607)	
Employment Place			
University hospital	146 (49.8)	1,263 (0,419–3,811)	0.31
Training-research hospital	72 (24.6)	0,379 (0,08–1,808)	
State hospital	35 (11.9)	1,182 (0,141–9,929)	
Private hospital/Office-based	32 (10.9	Nil	
Retired/unemployed	8 (2.7)		
Academic title			
Trainee	115 (39.2)	Nil	0.007*
Specialist doctor	112 (38.2)	4,281 (0,739–24,803)	
Assistant professor	20 (6.8)	2,702 (0,341–21,426)	
Associate professor	24 (8.2)	0,213 (0,03–1,503)	
Professor	22 (7.5)	3,60+17 (0–0)	
Workplace roles			
Operating room/Intensive care unit	249 (85.0)	Nil	0.10
Academician	8 (2.7)	635605852,6 (0–0)	
Equal participation	36 (12.3)	5,327 (1,138–24,928)	
Prior AI[a] use			
No	90 (30.7)	Nil	<0.001*
Yes	203 (69.3)	4.967 (2.572–9.591)	

[a]Artificial intelligence. *$P<0.05$ is considered statistically significant

Assistant professors exhibited the highest positivity rate among academic ranks, with 80.0% expressing positive attitudes and 20.0% remaining neutral; none reported negative views. Associate professors, however, displayed a lower positivity rate at 41.7%, with 50.0% remaining neutral and 8.3% expressing negative attitudes.

Prior experience with AI was significantly associated with positive attitude ($P < 0.001$). Participants with prior AI experience showed greater positivity (80.8%), compared to those without prior AI experience (44.4%).

The survey also explored participants' use of AI in professional and personal contexts. A total of 69.3% reported prior use of AI tools. The most common applications included translation tasks (46.1%), personal use (43.3%), academic writing (26.3%), preparing educational materials (23.2%), anesthesia-related tasks (12.6%), and assessing patient-related risks (7.2%).

Despite these diverse applications, participants expressed concerns about the potential for AI to replace specific tasks or reduce income in the future. Overall, 54.6% believed that AI-powered systems could impact their roles as anesthesiologists. Among these, 30.0% anticipated this change to occur in more than 10 years, 15.7% expected it within 10 years, and 8.5% believed it could happen within 5 years. Despite these concerns, many participants acknowledged AI's potential to assist across all areas of anesthesiology in the future.

The logistic regression analysis examining factors influencing positive attitudes toward AI revealed no significant differences in attitudes based on workplace or gender. However, a significant association was observed with age groups, with individuals aged 46–55 demonstrating a significantly more positive attitude toward AI ($P = 0.03$). Additionally, years of professional experience were linked to AI attitudes, showing a notable decrease in positivity with those more than 5 years of experience ($P = 0.04$). While no significant differences were found across workplace types, professors exhibited markedly higher positive attitudes toward AI compared to other academic titles ($P = 0.007$). Clinicians displayed more positive attitudes toward AI compared to academicians, and participants with prior AI experience reported significantly more favorable views than those without ($P < 0.001$). The results of the regression analysis are presented in Table 1.

When asked about the areas in which AI is anticipated to assist anesthesiologists in the future, most participants indicated that AI would be beneficial in clinical domains such as preoperative assessment (93.1%), patient care optimization in intensive care units (88.4%), closed-loop anesthesia management (80.2%), and supporting regional anesthesia procedures (75.8%). The most highly endorsed applications were academic support (95.2%) and medical education (91.2%). Postoperative pain management received comparatively less support (64%) but was still regarded positively [Figure 1].

In response to questions about perioperative procedures that could potentially be performed independently by AI-assisted applications in the future, 56.3% of participants identified perioperative risk prediction, and 66.9% highlighted postoperative pain management as the most supported areas. In contrast, invasive procedures such as intubation (22.6%), catheterization (28.3%), and regional anesthesia (28.6%) received lower levels of support, although higher rates of uncertainty were observed for these domains [Figure 2].

While considering the positive and negative aspects of AI applications, participants highlighted the most favorable opinions as utility (89.1%) and time efficiency (91.5%). Patient safety (61.5%) and effectiveness (75.4%) were also supported, although neutrality demonstrated a higher rate of uncertainty (34.8%). On the negative side, participants identified the ambiguity of responsibility in cases of complications or malpractice as the greatest concern (87.3%). Other significant concerns included inaccuracies in information (62.8%) and the black box algorithms (55.3%) [Figure 3].

81.2% of participants believed that the use of AI would lead to ethical problems. Among those who anticipated such issues, 62.8% expressed concerns about challenges in ensuring patient privacy and confidentiality, 73.4% highlighted the ambiguity of responsibility in cases of complications or malpractice, 66.9% cited concerns over copyright issues in academic publications, 41.3% pointed to bias, and 67.5% raised concerns about misinformation [Figure 4].

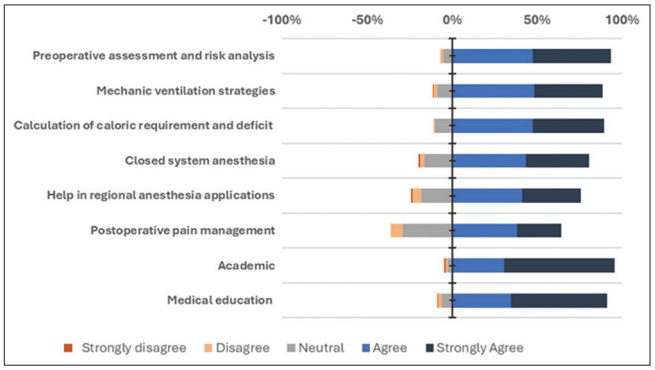

Figure 1: Anticipated assistance of AI in the future

Discussion

This survey examined Turkish anesthesiologists' perspectives on AI, revealing predominantly positive attitudes, significantly influenced by prior experience. Gender, academic titles, employment settings, and professional experience showed nuanced associations. AI's potential in academic support, education, and noninvasive clinical tasks was widely acknowledged, while skepticism remained about its role in invasive procedures. Ethical concerns, liability issues, and career impacts highlight the complexities of AI integration, emphasizing the need for robust frameworks. To our knowledge, this is the first study to explore AI attitudes among Turkish anesthesiologists.

Among the participants, 69.6% held a positive view of AI, placing Turkish anesthesiologists in front of their counterparts from the US.[9] Existing literature highlights that attitudes toward AI are shaped by personality traits and sociocultural factors.[11,12] Specifically, cultural dimensions such as self-reliance, egalitarianism, tendency to avoid risk, and doubtful toward technology play pivotal roles in shaping these perspectives.[13] It is plausible that Turkish anesthesiologists embody these traits, contributing to their positive outlook on AI. Future studies integrating personality profiling and AI-related research are essential to further substantiate and deepen our understanding of this relationship.

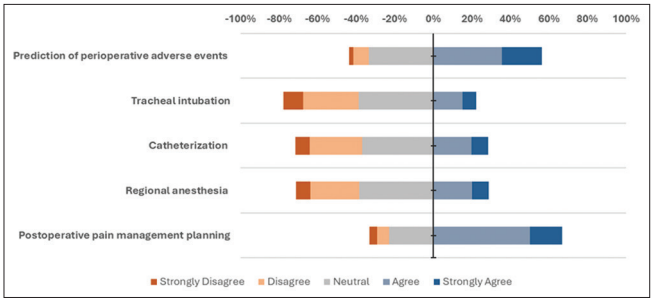

Figure 2: Independent AI-assisted applications in the future

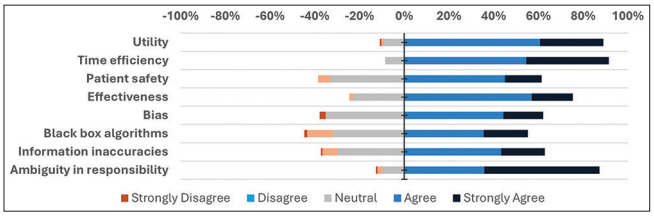

Figure 3: Positive and negative aspects of AI application

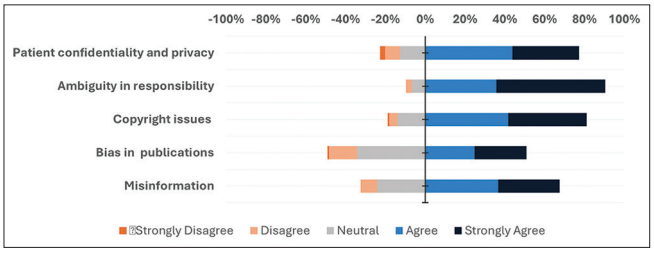

Figure 4: Ethical problems regarding AI use in anesthesiology

In the univariate analysis, gender was found to significantly impact AI attitudes; however, this association was not observed in the logistic regression model. This disparity may be attributed to the confounding influence of age on the relationship between gender and AI attitudes. A deeper analysis revealed that participants aged 46–55 years were almost 3.75 times more likely to have a positive attitude toward AI, and notably, more than two-thirds of this age group were female. When compared to cross-sectional studies conducted among anesthesiologists in Saudi Arabia and the United States, the proportion of female respondents in our study was notably higher, at 58%, compared to 14.7% and 25.1%, respectively.[9,14] This gender distribution may contribute to a more homogeneous and less skewed dataset, enhancing the representativeness of our findings.

Participants with prior AI experience were nearly five times more likely to hold a positive perception of AI, a trend similarly observed in the surgical setting.[9,15] The correlation between prior experience and favorable attitudes has been extensively documented in the field of technology, and our findings suggest that this relationship extends to AI as well.[16,17]

In the univariate analysis, contrary to previous literature,[9,15] years of working experience did not significantly impact AI attitudes. However, logistic regression revealed a negative association between increased age and AI attitudes. Specifically, working experience exceeding 15 years was associated with a decreased likelihood of having a positive attitude toward AI, which in our study overlaps with characteristics such as age (>55 years) and academic title (associate professor). Notably, all responding professors exhibited positive attitudes toward AI, potentially explained by their administrative and educational roles.

In our cross-sectional study, AI was most commonly utilized for academic support, medical education, and noninvasive procedures, predominantly in the preoperative period, aligning with its current applications across various countries and specialties.[9,18,19]

The majority of participants in our survey expressed favorable attitudes toward AI applications in various areas of anesthesiology, including preoperative assessment,

risk analysis, mechanical ventilation strategies, caloric calculations, closed anesthesia systems, and assistance with regional anesthesia and pain management. AI's potential in academic and medical education was also widely recognized. This cautious approach may be attributed to the current applications of AI, which are predominantly focused on assisting rather than replacing clinicians. AI-assisted tasks such as closed anesthesia systems for monitoring the depth of anesthesia and tools for recognizing anatomical structures in ultrasound-guided regional anesthesia are among the most studied and commonly utilized intraoperative functions.[4,20] Studies evaluating AI systems for depth of anesthesia monitoring have employed various accuracy metrics, including sensitivity, specificity, correlation coefficients, and predictive values. While the outcomes vary, the collective evidence suggests that AI shows significant promise in providing accurate and reliable assessments.[21-23] Similarly, research on anatomical structure recognition and needle targeting during ultrasound-guided regional anesthesia has demonstrated that AI-assisted systems enhance precision and reduce clinical errors.[24,25] Anesthesiologists' familiarity with these types of AI applications likely contributes to their positive perception of AI in these specific contexts.

Regarding the potential tasks an AI-assisted program could independently perform, less than one-third of participants believed it could execute invasive tasks such as tracheal intubation, catheterization, or regional anesthesia. Conversely, more than half of the participants supported AI in noninvasive perioperative tasks like pain management planning and predicting perioperative adverse events. The skepticism toward AI's role in invasive procedures is a common sentiment among anesthesiologists and surgeons.[9,15,18,19] This reluctance may stem from the fact that, for noninvasive tasks, clinicians retain the final decision on whether to act on AI recommendations. However, this autonomy diminishes when AI independently performs invasive procedures, potentially increasing the clinician's vulnerability to liability in the event of a complication.

Our study aligns with existing literature on the positive and negative concepts associated with AI. Positive perceptions centered on AI's utility, time efficiency, effectiveness, and contributions to patient safety.[9,14,19,26] In contrast, negative perceptions focused on concerns such as medical liability, patient privacy, and the 'black box' effect.[9,18,26,27] The most frequently encountered negative concept in our study was related to medical liability, specifically the ambiguity in responsibility when complications arise, reported by 87.3% of participants. Surprisingly, this percentage was significantly higher than that reported by our counterparts in the US—where anesthesiologists face approximately 5% of medical claims annually,[28] and 10% of these claim payments exceed $1 million[29]—with only 47% expressing concerns about liability and malpractice.

Although clear definitions about who is responsible in which medical complication— developers who enabled the AI program, physicians who used the program, or the hospital who provided the program to the physician—lacks, models are being made to define the party who is liable in case of a complication and divide the liability.[30] In our study, more than 80% of participants believed that the use of AI would lead to ethical challenges. With the increasing use of large language models for academic writing, it is important to consider the risk that information provided to these programs could become part of their outputs, potentially appearing in other articles without proper citation, thereby causing serious copyright issues. One should avoid sharing sensitive, unpublished, or proprietary data with large language models unless the researcher is certain that the data provided are not be stored or reused.

Lastly, in our study, 54.6% of participants expressed concerns that AI could negatively impact their careers through job displacement or income reduction. This percentage is significantly higher than that reported in similar studies among US anesthesiologists (45%)[9] and pathologists (19.7%).[27] This disparity may stem from differences in the current economical status of the countries, inflation and pension systems among different countries, and specialities.

Our study has limitations. First, we were unable to reach every Turkish anesthesiologist who is a member of the Turkish Society of Anesthesiology and Reanimation. Sending reminder emails or choosing a second method to distribute the survey could have improved the response rate and minimized nonresponse bias. Additionally, the questionnaire distribution method may have introduced selection bias as younger physicians were more likely to participate. Although our questions were based on previous studies, a Delphi study could have been employed to incorporate a broader range of concepts and categories.

Conclusion

Turkish anesthesiologists demonstrated positive attitudes toward AI, particularly those with prior AI experience. Academic title and professional experience influenced perceptions, highlighting AI acceptance's complexity. While AI was widely supported for academic, educational, and noninvasive clinical tasks, skepticism persisted regarding its

role in invasive procedures due to concerns about liability, bias, algorithmic transparency, and ethical challenges. These findings highlight AI's potential to improve efficiency, accuracy, and patient safety while emphasizing the need for strong legal, ethical, and professional frameworks. This study provides a foundation for understanding AI perceptions and informs efforts for context-specific AI integration in clinical practice.

Ethical approval

The study was approved by the Gazi University Ethical Committee (Protocol no. 2024-486, Date: 03.04.2024).

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Conflicts of interest

There are no conflicts of interest.

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